The Institute for Interconnecting and Packaging Electronic Circuits
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IPC-TM-650
TEST METHODS MANUAL

Number	
2.6.23	
Subject	
Test Procedure for Steam Ager Temperature Repeatability	
Date	Revision
7/93	
Originating Task Group	

1.0 Scope This test procedure measures the temperature repeatability inside steam agers used to condition components prior to solderability testing. It should be applied at installation and after any modification to the equipment and/or its location.

2.0 Applicable Documents

IPC-PC-90	General Requirements for Implementation of Statistical Control
MIL-STD-202	Test methods for Electronics and Electrical Components Parts
MIL-STD-750	Test Methods for Semiconductor Devices
MIL-STD-883	Test Methods of Microelectronics
MIL-STD-45662	Calibration Systems Requirements
ANSI/ASQC Z1.1	Guide for Quality Control Charts
ANSI/ASQC Z1.2	Control Chart Method of Analyzing Data
ANSI/ASQC Z1.3	Control Chart Method of Controlling Quality During Production
ANSI/J-STD-002	Solderability Tests for Components Leads, Terminations, Lugs, Terminals and Wires

3.0 Test Specimens None required

4.0 Apparatus The following test equipment shall be used during the tests:

4.1 Type T copper-constantan thermocouple wire, 24 AWG, ±0.5°C [±0.09°F] accuracy minimum, premium grade.

Note: PTFE insulation is preferred.

4.2 Thermocouple Temperature Indicator, with an accuracy of ±0.5°C [±0.9°F] minimum, with capability for type T thermocouples, and be calibrated in accordance with MIL-STD-45662 or the equivalent.

It is recommended that the thermocouple indicator have capability to log data and be able to take all readings within 2 minutes.

Since readings must be taken periodically, it is recommended that the indicator have capability for pre-settable time delay between measurements.

Note: Although the specific equipment used to develop this method was as specified above, other thermocouple types and temperature indicators may be used provided the requirements of 5.1 are met.

4.3 Hot plate with 500 ml glass beaker

4.4 The steam ager as used to perform component solderability testing per MIL-STD-202, Method 208; MIL-STD-883, Method 2003; or MIL-STD-750, Method 2026; or ANSI/J-STD-002 as applicable.

5.0 Test Procedure

5.1 Thermocouple Calibration All thermocouples to be used during the steam ager test shall first be checked. Loosely bundle the thermocouples and place in a 500 ml glass beaker of vigorously boiling water, heated by a hot plate.

Measure the temperature indicated by each thermocouple. All thermocouples should indicate the same temperature ±0.5°C [±0.9°F] to the local boiling point of water. If any thermocouple differs by more this amount, the weld bead shall be reworked (and all thermocouples reverified), or the thermocouple shall be discarded for the purpose of this test.

5.2 Install Thermocouples Install the thermocouples in the ager at the component level. All thermocouple weld beads shall be at the same height ±6.35 mm [±0.25 in]. The distance from the weld to the water shall be measured prior to the test.

All thermocouples shall be at least 25.4 mm [1 in] away from any wall or bulkhead. The thermocouples should be distributed evenly around the normal working area inside the ager, and the location shall be recorded. Ten thermocouples shall be used in larger agers, eight in smaller agers. For example, if the ager uses five small drawers, a thermocouple centered in the front and back halves of the drawer would be sufficient. If no drawers are used, the thermocouples should be distributed around the areas where parts are usually placed.

Each thermocouple shall be secured using positive mechanical means. For example, the thermocouple wire could be wound around a piano wire secured across the width of the ager.

The natural airflow within the ager should be preserved. Extra baffles or wire mesh screens should not be included for this test, if not used during regular solderability testing. Venting should be preserved as it is during normal testing.

The end of the thermocouple, including the weld bead and exposed wires, should be oriented vertically (pointing upward) to prevent water drops from collecting on them.

5.3 Performing the Test Turn on the ager and allow to stabilize until measurement procedures used during regular testing indicate stability has been achieved.

> *Note:* Four hours is usually required in most agers to achieve stability, and this ''warmup'' time should be included in the production part test procedure.

Start the test, logging temperature every 15 minutes for 8 hours. (if the data clearly indicates that the natural variability within the chamber varies more quickly, the sampling frequency can be increased as necessary)

When logging temperatures, all thermocouples should be measured simultaneously, or within 2 minutes maximum. Temperatures shall be recorded in degrees Celsius. Measure temperature to the nearest 0.1 degree.

The steam agers shall not be disturbed during the test, except for routine maintenance or inspection procedures; as used during normal testing. The ager shall be tested without other components inside.

5.4 Test Conditions Test the temperature stability at the temperature set point used for solderability testing.

5.5 Data Analysis

5.5.1 Record the following data for each test.

a. Ager manufacturer and model number
b. Temperature indicator type, date of calibration
c. Test date
d. Sampling frequency
e. Total vent area on chamber lid [sq.cm]
f. Total chamber cross-sectional surface area [sq.cm]
g. Total volume of air in chamber [cu.cm]
h. Set point temperature
i. Test location
   i. in hood
   ii. on table against wall
   iii. on table in open room
j. Location of room air conditioning vents (include sketch)
k. Notes on any special conditions during test
l. Distance from thermocouples to water level
m. Location of thermocouples inside ager (include sketch)
n. Room temperature when testing

5.5.2 Test Data Prepare a matrix of test data, showing temperature of each thermocouple at each sampling interval.

5.5.3 Control Charts Prepare X-bar and R charts with appropriate control limits. A control limit calculation form is shown in Appendix 1. Further instructions on preparation of control charts can be found in IPC-PC-90 or ANSI/ASQC Z1.1, Z1.2, and Z1.3.

Subgroups shall consist of all thermocouples placed in the ager (8 or 10), and which are measured simultaneously during the test.

The charts shall be considered out of control if any of the following applies:

a. any one data point is beyond the control limits
b. any 2 or 3 consecutive points are near a control limit (outer third)
c. a run of 8 or more points is above or below the center line
d. a run of 6 or more points is increasing or decreasing

5.5.4 Process Capability Histogram Prepare a process capability histogram, using data ranges of 1/2°C or less.

Estimate the mean and standard deviation of the data.

5.5.5 Process Capability Index Calculate the process capability index, Cp using the equation shown below (from IPC-PC-90 example 7.5.6.2) for specification limits of ±1°C [±1.8°F], ±2°C [±3.6°F], ±3°C[±5.4°F] and ±4°C[±7.2°F].

$$Cp = \frac{USL-LSL}{6S}$$

Where,

Cp = capability index
USL = upper specification limit
LSL = lower specification limit
S = process standard deviation

Include a plot of Cp against specification tolerance range.

6.0 Notes

6.1 Care should be exercised when interpreting analysis results. Cp may not be meaningful if the X-bar or R charts are out of control, or the process capability histogram is grossly non-normal. Consult IPC-PC-90 or ANSI/ASQC Z1.1, Z1.2 and Z1.3 for further details.